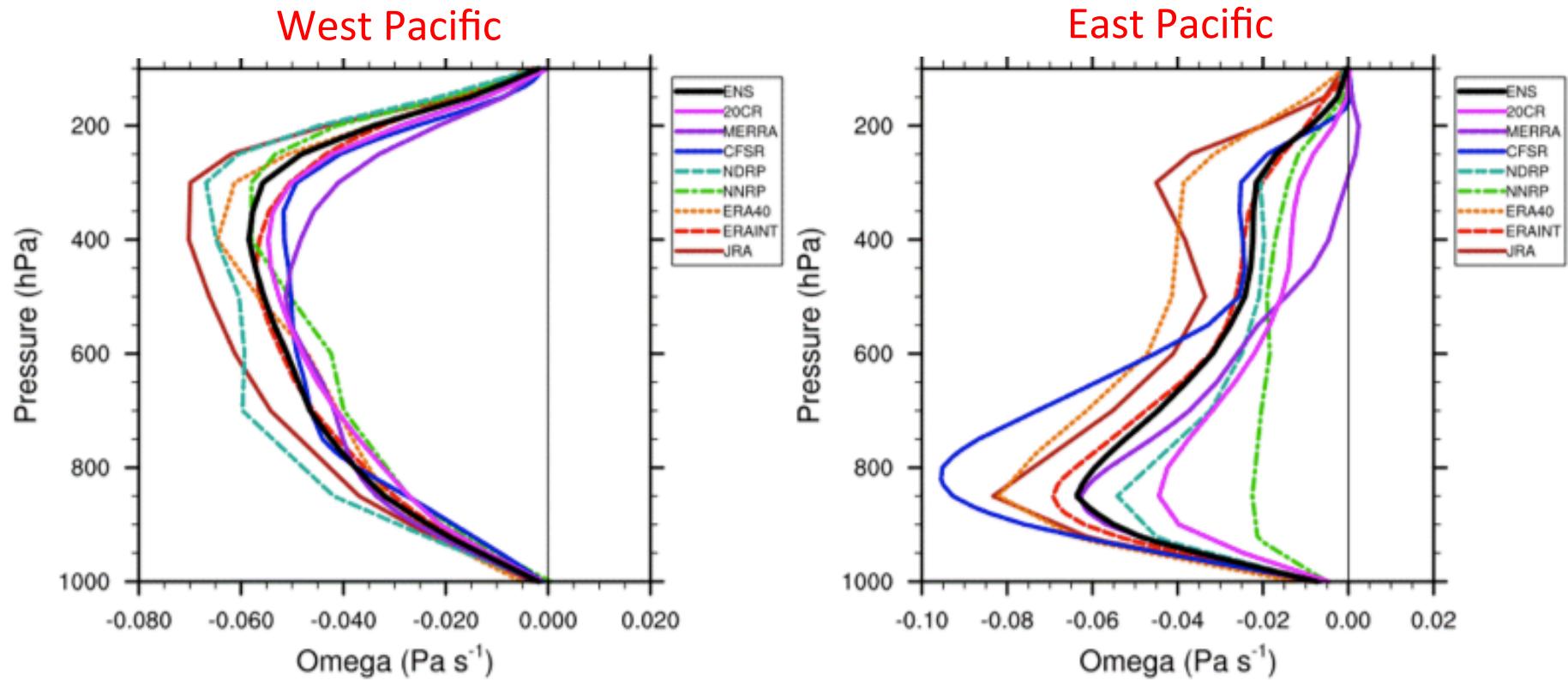


# Vertical motion and heating in the tropical Pacific

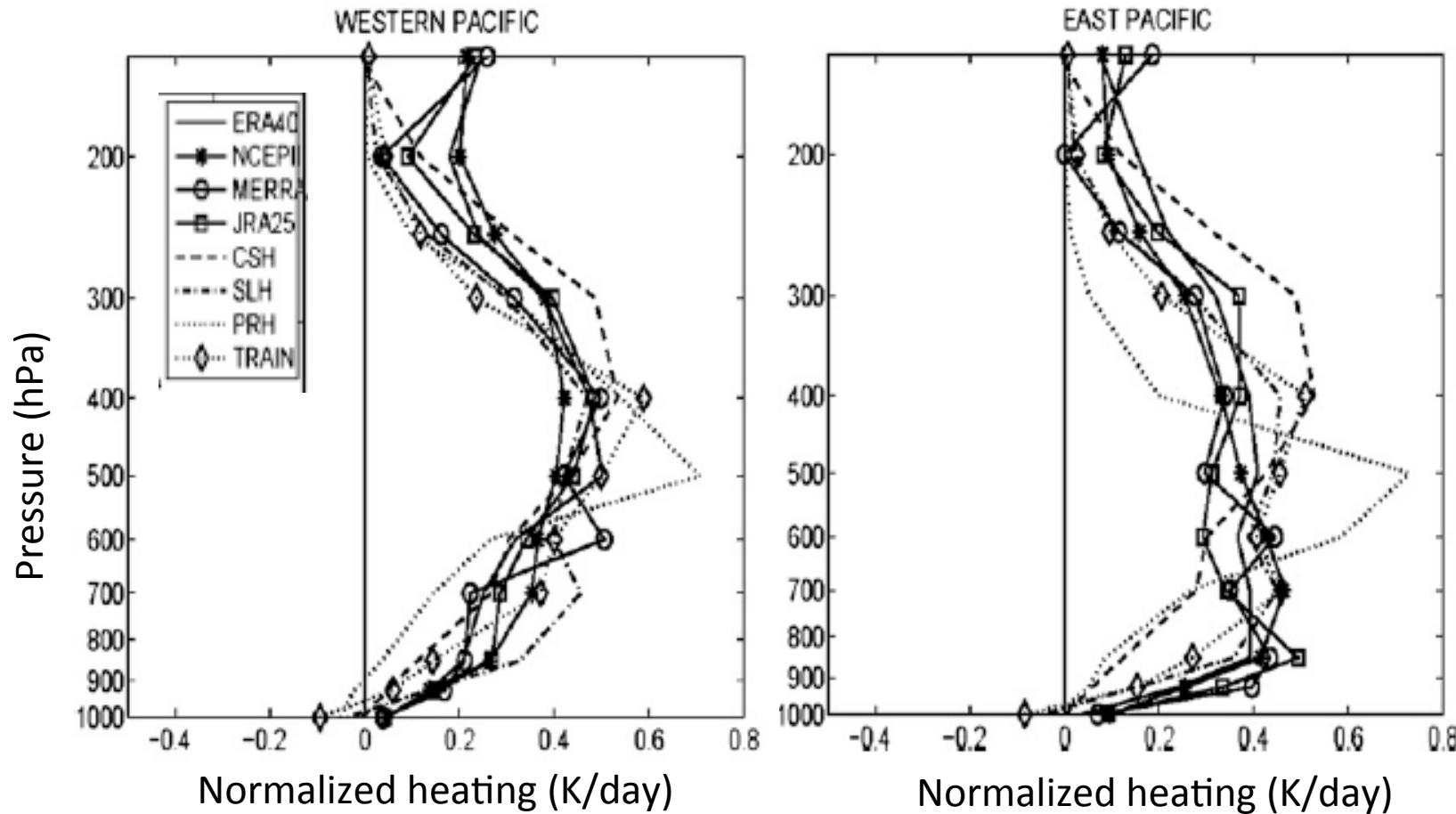
Courtney Schumacher and Keith White  
Texas A&M University

# Pacific Ocean vertical motion



Reanalyses show top-heavy vertical motion in west Pacific and bottom-heavy vertical motion in east Pacific ITCZ (with more variability in east Pacific)

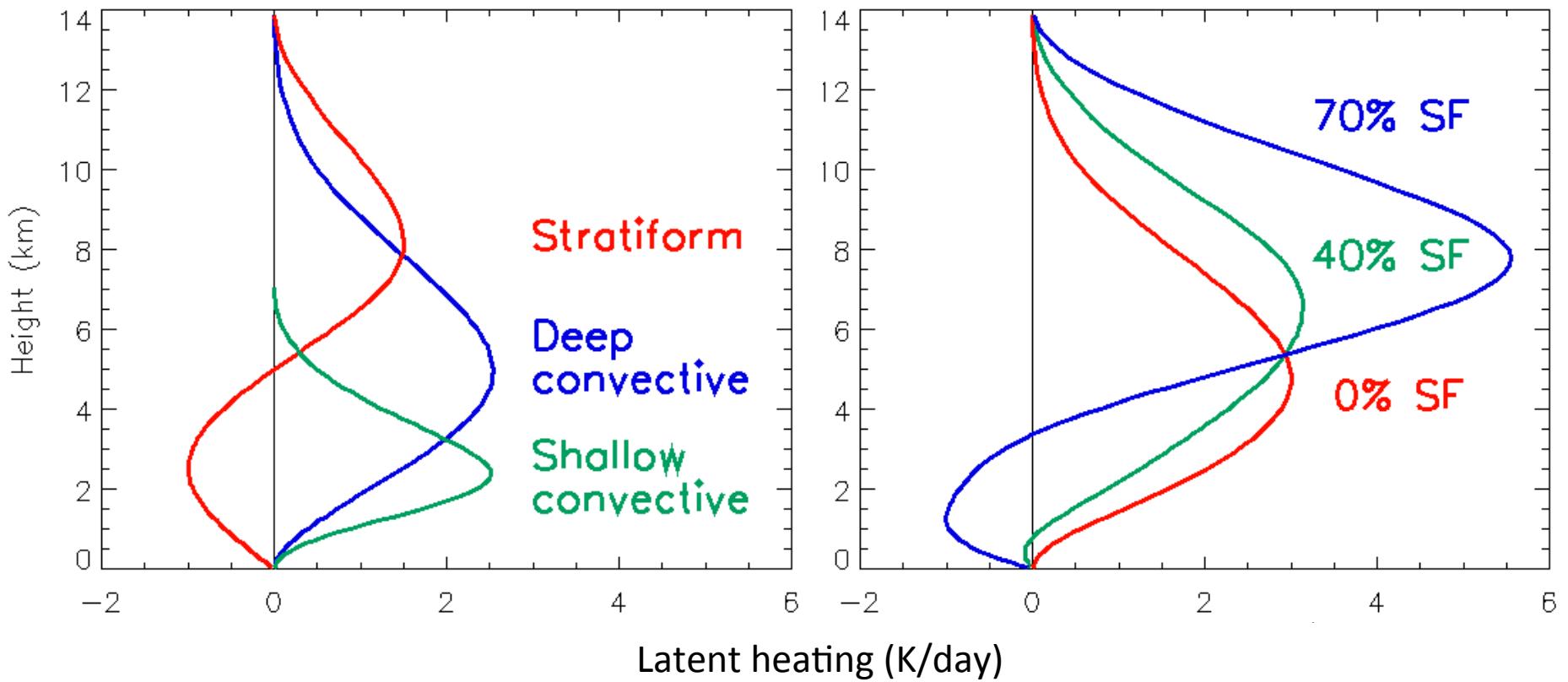
# Pacific Ocean heating



Reanalyses (solid lines) show top-heavy heating in west Pacific and bottom-heavy heating in east Pacific, while TRMM heating (dashed and dotted) is more top heavy in both regions

Hagos et al. (2010)

# Simplified latent heating retrieval

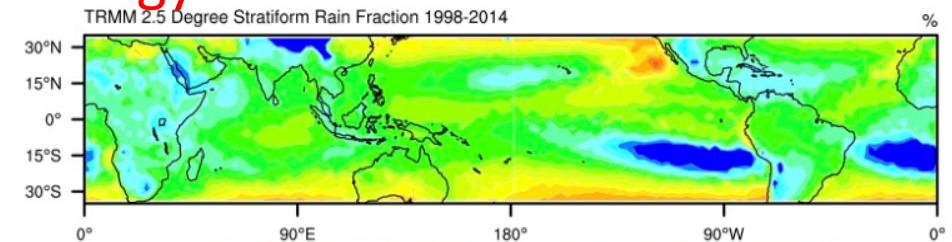
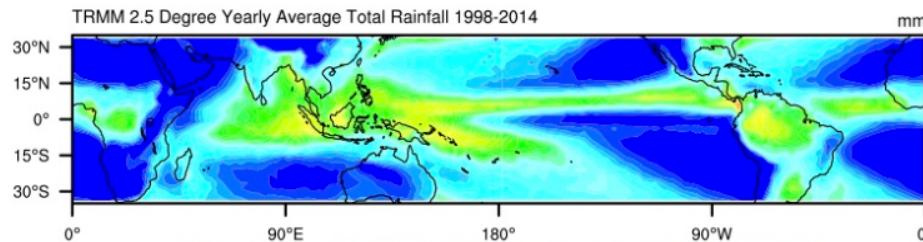


In the tropics, more stratiform rain leads to higher peaks in heating

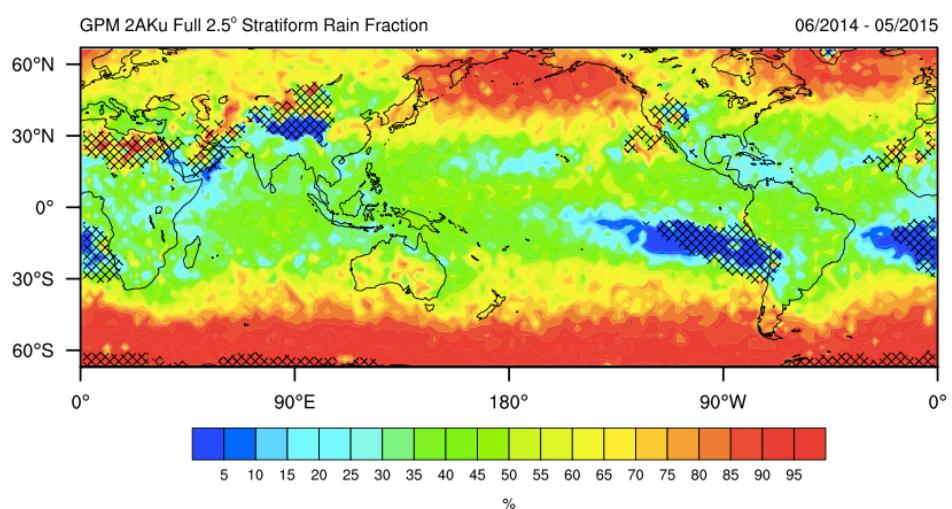
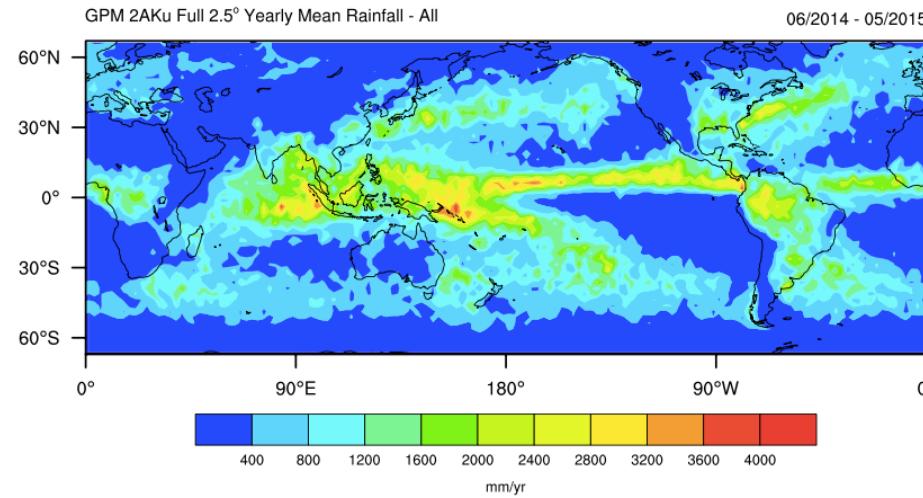
Schumacher et al. (2004)

# Rain and stratiform rain fraction

PR climatology



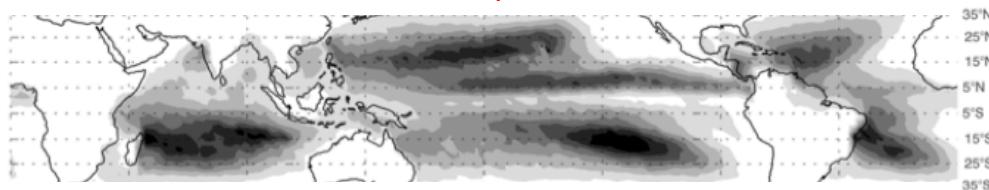
DPR Ku (June 2014 – May 2015)



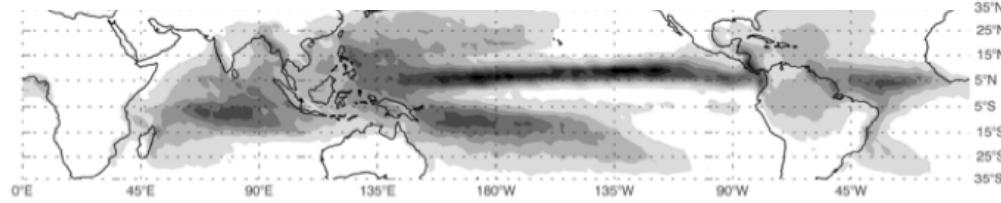
TRMM and GPM both show that the west Pacific and east Pacific ITCZ receive comparable rain amounts, but that the east Pacific has slightly higher stratiform rain fractions

# Shallow rain types

PR shallow, isolated

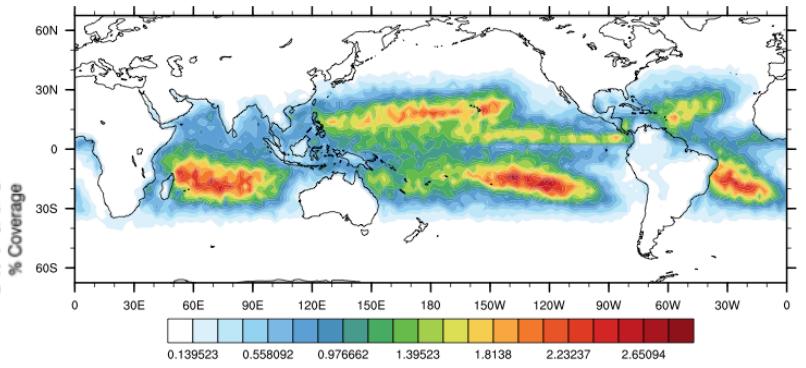


PR shallow, non-isolated

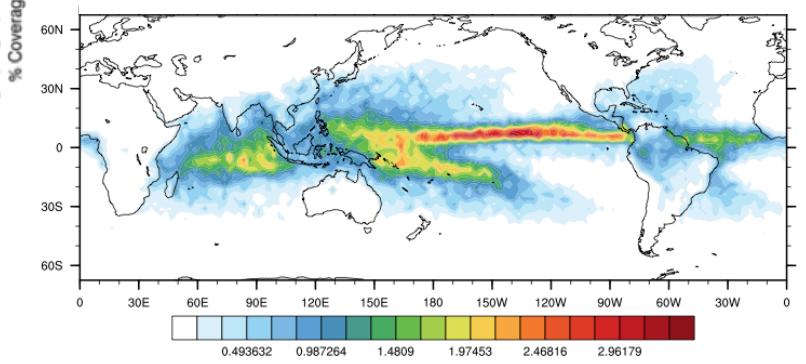


Funk et al. (2013)

DPR shallow, isolated

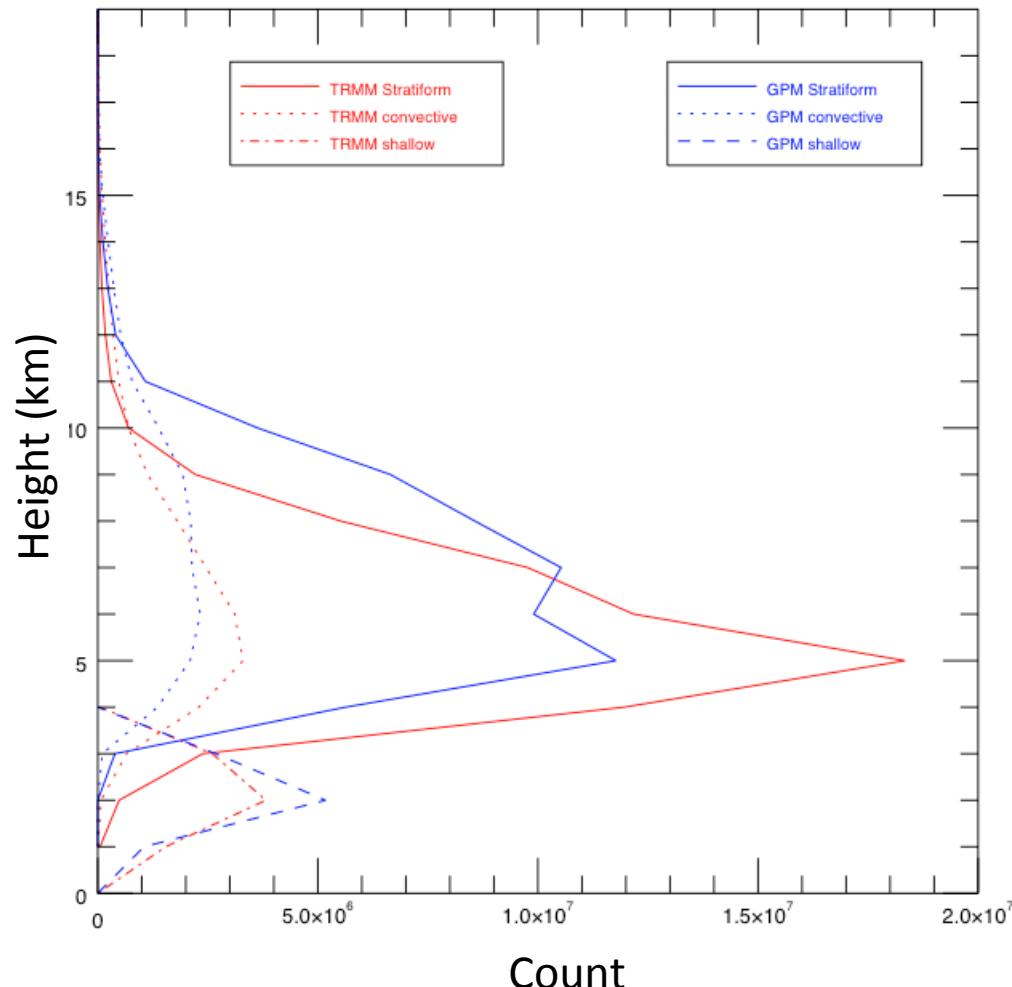


DPR shallow, non-isolated



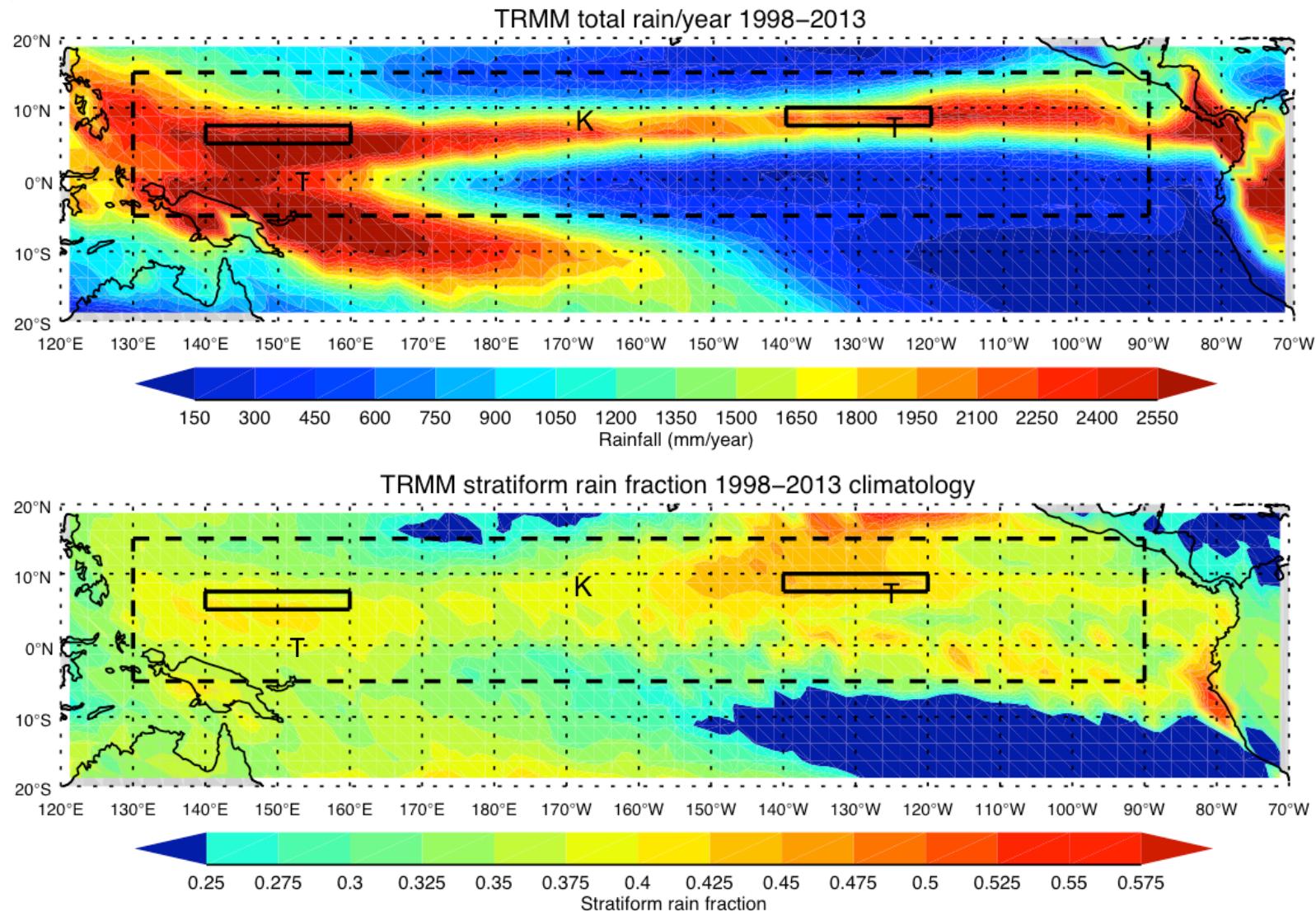
DPR Ku shows very similar occurrence of both shallow rain types compared to the PR climatology (i.e., there is no evidence that TRMM misses significant shallow convection in Pacific ITCZ)

# Storm top heights in Pacific ITCZ

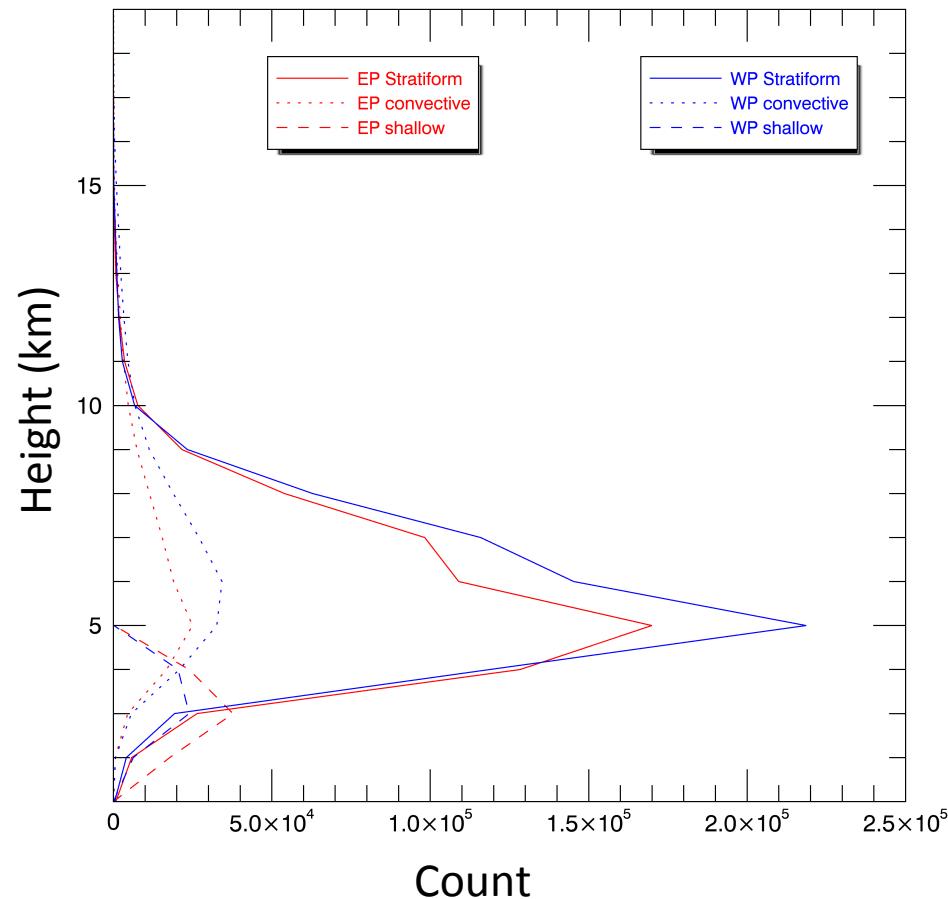


DPR Ku (blue) sees ~1-2 km higher convective and stratiform storm tops than PR (red), shallow cloud populations generally similar

# Drilling in on the Pacific ITCZ

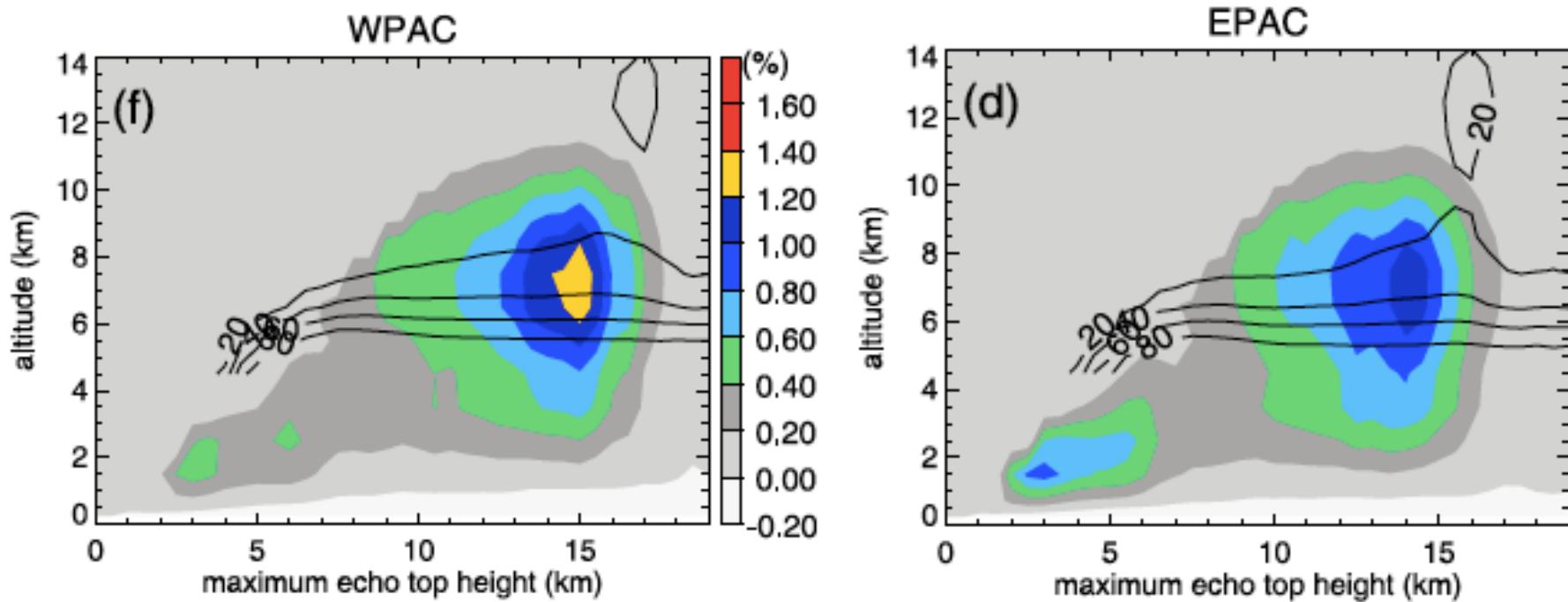


# PR storm top heights (JJA)



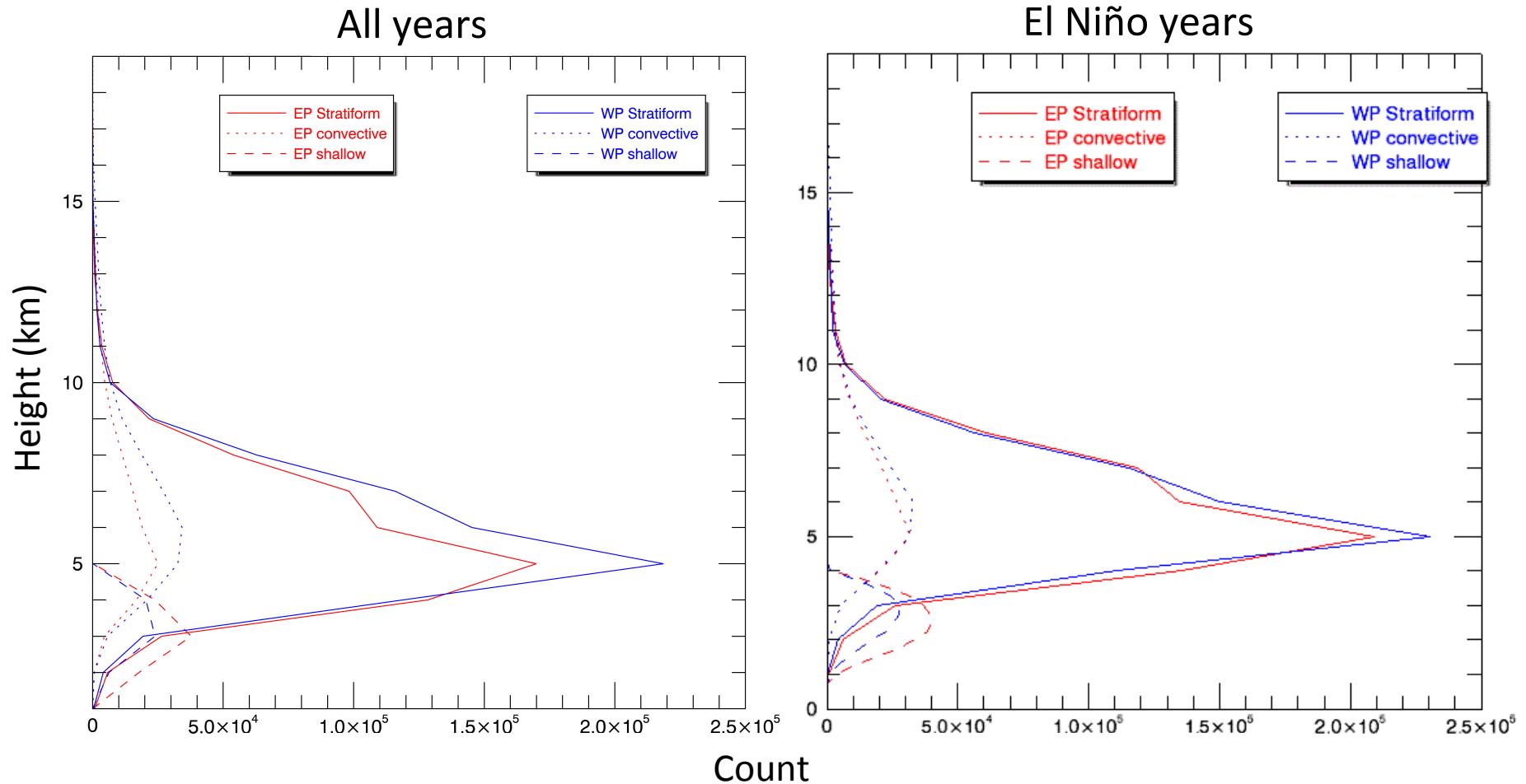
More shallow convection occurs in east Pacific (red), west Pacific (blue) has more stratiform rain and deep convection, overall shallow rain contribution is ~10%

# Latent heating from SLH



While more latent heating comes from shallow systems in the east Pacific compared to the west Pacific, the majority of heating still comes from deeper storms

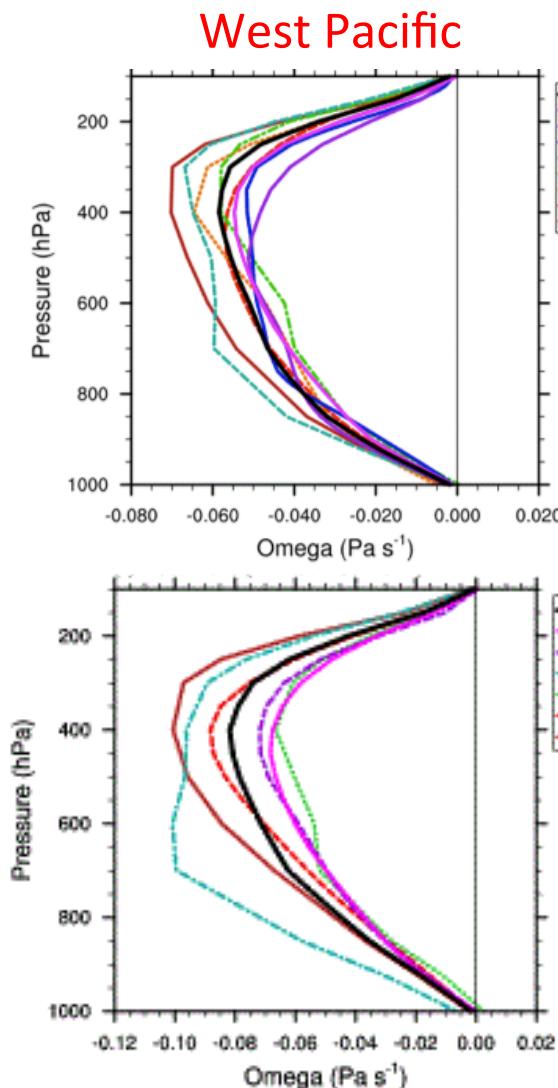
# Changes in storm tops during El Niño



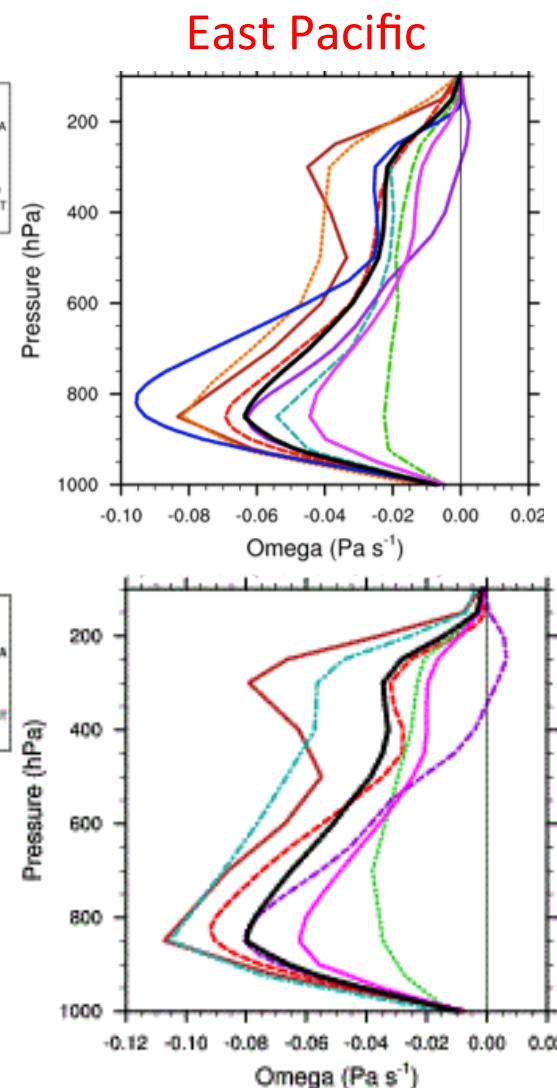
Deep storm systems in the west and east Pacific ITCZ become more similar during El Niño although there is less change in shallow rain

# Changes in omega during El Niño

All years

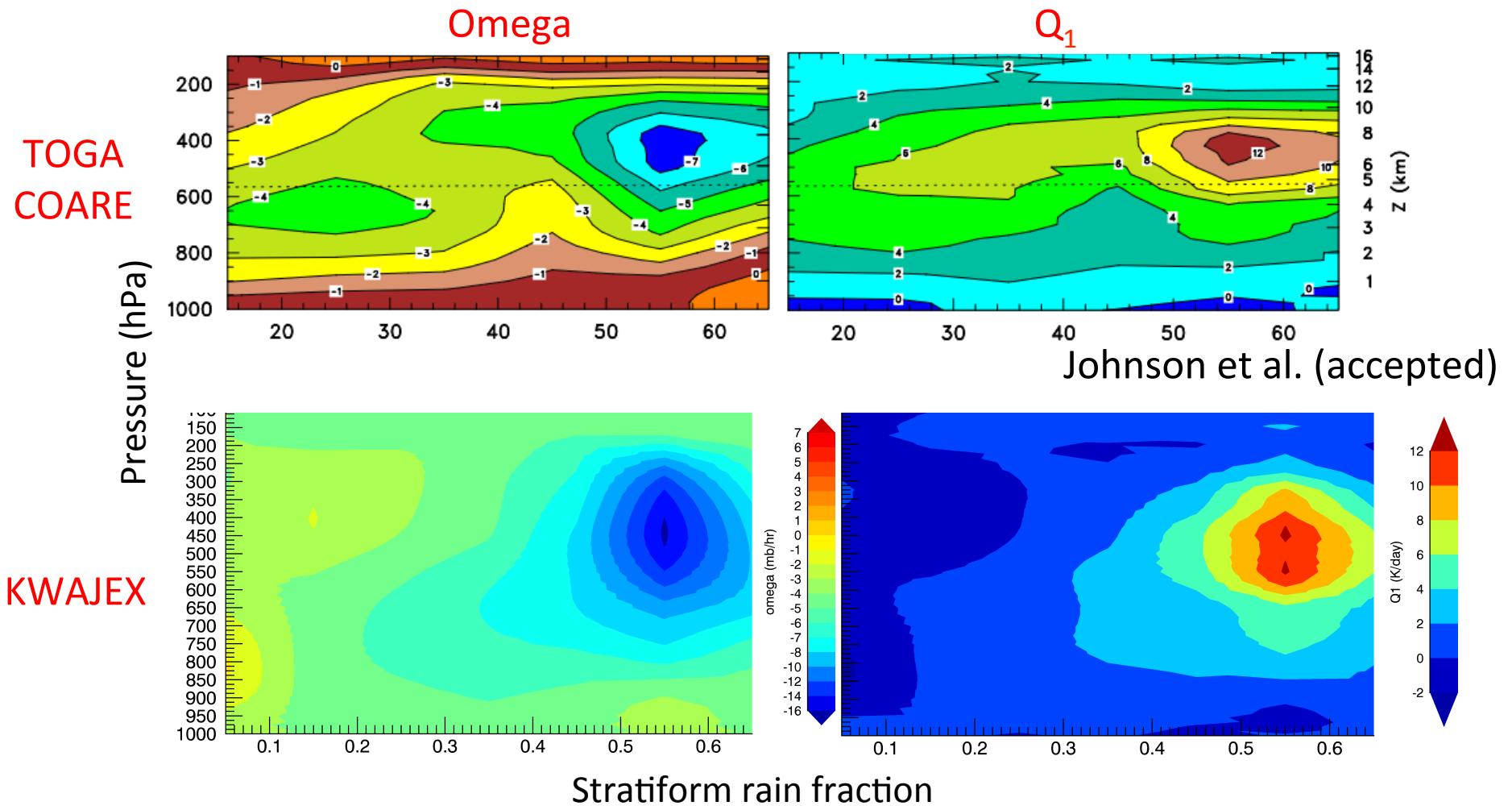


El Niño  
years



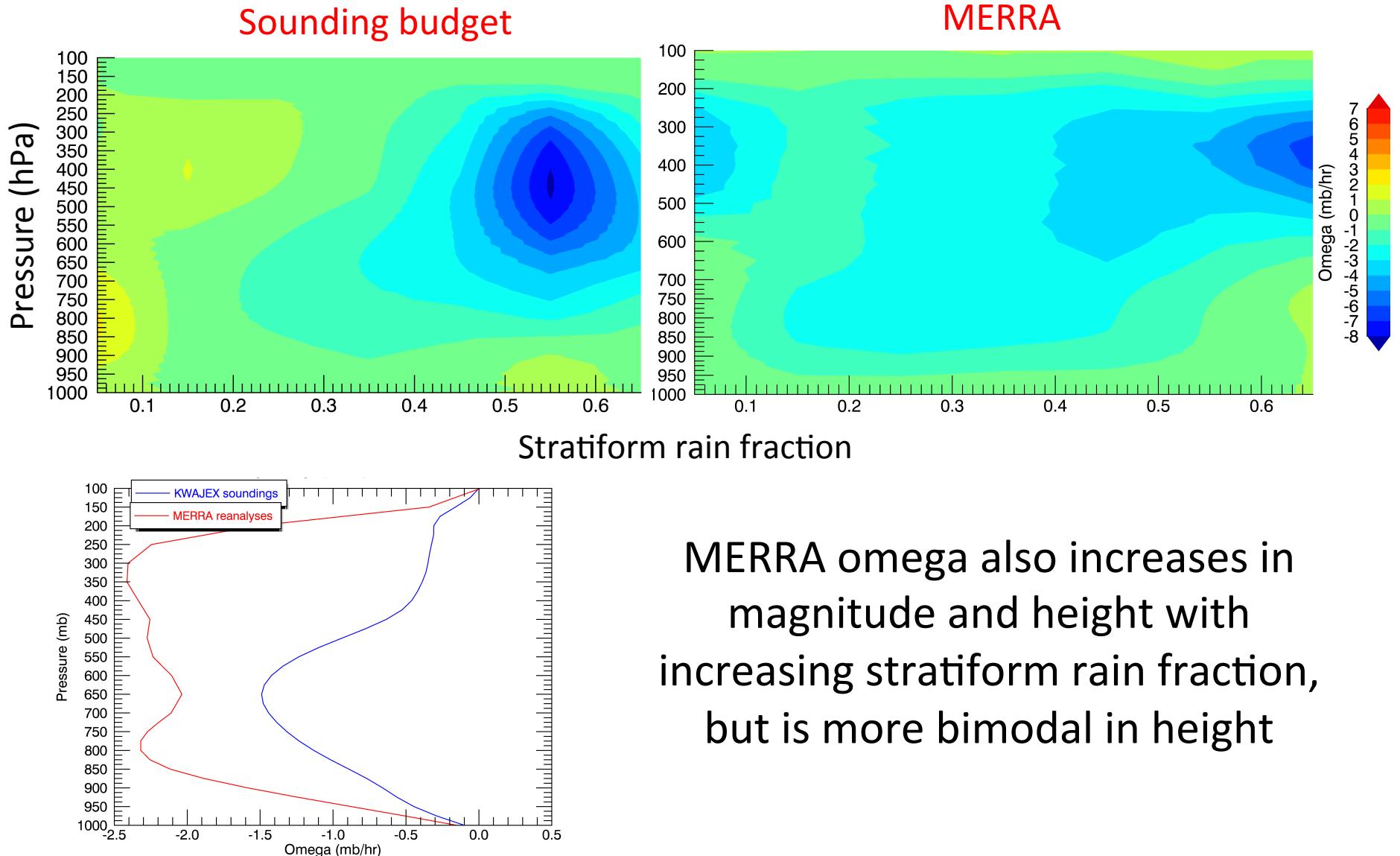
Reanalysis  
omega  
remain  
bottom  
heavy  
during El  
Niño

# Changes in $\omega$ and $Q_1$ with SF rain fraction

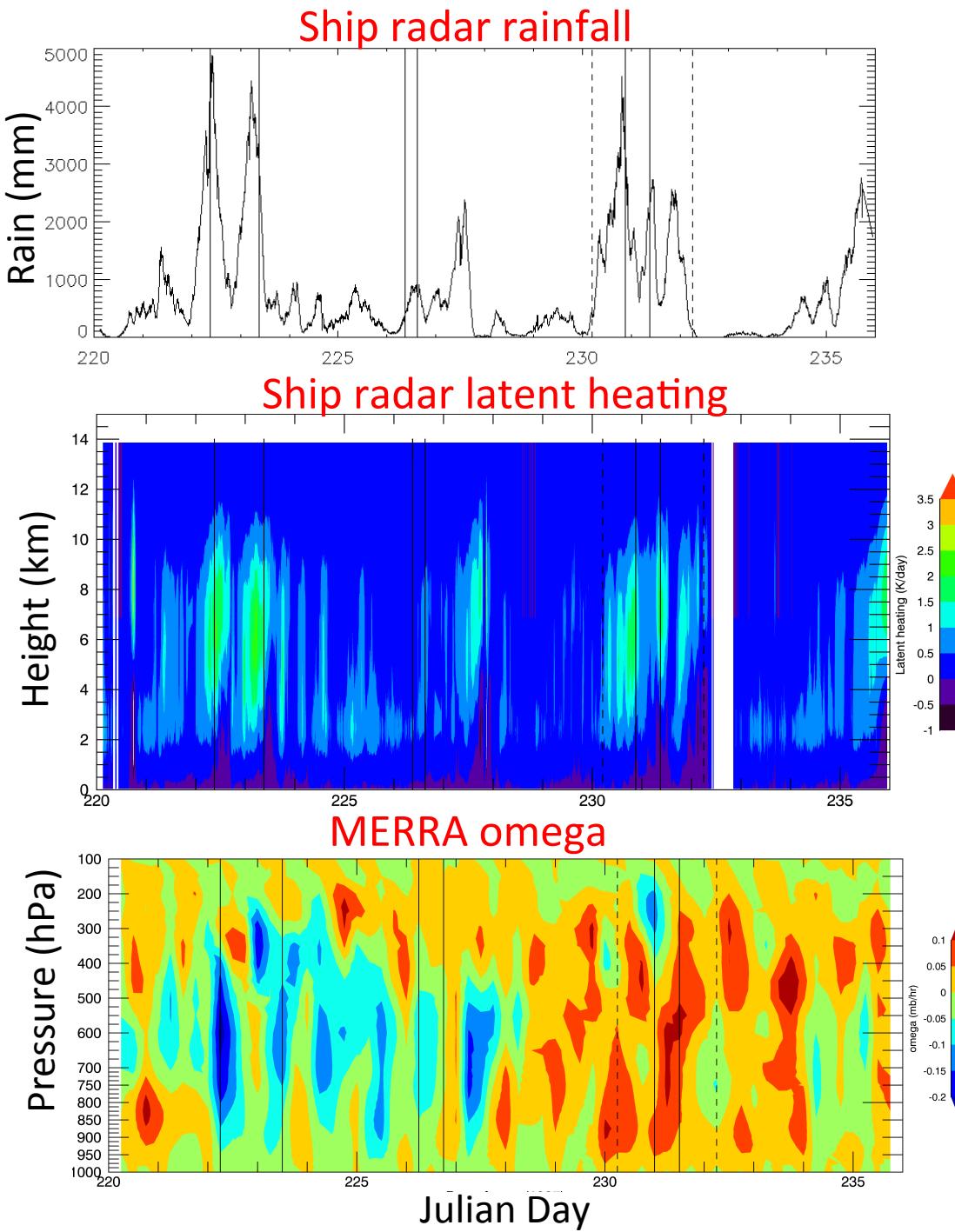


Omega and  $Q_1$  both increase in magnitude and height with increasing stratiform rain fraction

# KWAJEX omega budget vs MERRA



# TEPPS



- TEPPS experienced episodic events associated with Kelvin and easterly waves (Straub and Kiladis 2002, Serra and Houze 2002)
- The events had significant deep convective and stratiform rain regions that produced top-heavy heating
- MERRA captured these events only to varying degrees

# Conclusions

- The TRMM PR and GPM DPR are generally consistent in observations of storms across the tropical Pacific and show that while convective systems are slightly less deep in the east Pacific, shallow rain contributions remain negligible to the overall latent heating compared to deeper rain systems
- Reanalyses have trouble capturing the accurate vertical structure of storms in the east Pacific ITCZ making their low-level omega and heating peaks suspect